UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

GENLYTE THOMAS GROUP LLC,

Plaintiff/Counterclaim Defendant,

v.

ARCHITECTURAL LIGHTING SYSTEMS, a division of ARCH LIGHTING GROUP,

Defendant/Counterclaimant.

Civil Action No. 05-CV-10945 REK

DEFENDANT'S RESPONSE TO PLAINTIFF'S OPENING MARKMAN STATEMENT

Defendant, Arch Lighting Group, Inc. (ALS), submits this response to the Opening "Markman" Statement submitted by Plaintiff, Genlyte Thomas Group LLC ("Genlyte") relating to interpretation of the claims of the patent in suit, U.S. Patent No. 5,038,254 ("the '254 patent"). ALS previously submitted a statement as to interpretation of all claim elements. Its position as to claim interpretation has not changed. The full interpretation of all claim elements are set forth in ALS's Markman Statement. This response is limited to the errors and omissions in Genlyte's statement.

Despite Genlyte's unwillingness to agree to any of the interpretations of the claim language proposed by ALS, the parties respective opening statements show few differences. Both rely on the ordinary meaning for claim terms as supported by the intrinsic evidence and similarly define claim terms. There are, however, several distinctions which are relevant to this case. First, Genlyte erroneously seeks to rely upon knowledge of one skilled in the art to avoid the failure of the '254 patent to disclose structure for ceiling mounting the body of the lighting system as is necessary to interpret the claims. Second, Genlyte ignores and fails to offer any

definition for a principal term in the claims, the term "to direct light." Third, as a result of Genlyte's omission of directing light from its claim interpretations, it fails to provide a complete interpretation of the term "reflector." Each of these errors and omissions on the part of Genlyte are discussed in detail below.

I. Patent Specification Must Disclose Structure of Means-Plus-Function Claim.

Claims 1 and 3 of the '254 patent relate to a lighting system. The lighting system includes a body having several fixtures. One of the necessary elements of these claims, "means for ceiling-mounting said body," is written in means-plus-function format and requires a particular claim interpretation process. The parties agree as to the two-step process for interpreting the claim terms written in means-plus-function format. First, the court must identify the function recited in the claim. Second, the court must identify the structure set forth in the specification for performing that function. *Asyst Tech., Inc. v. Empak, Inc.*, 268 F.3d 1364, 1369 (Fed. Cir. 2001). Furthermore, the parties agree that the recited function is "ceiling-mounting said body." However, the parties differ as to the determination of corresponding structure in the specification for performing the recited function.

ALS indicated in its Markman Statement that the '254 patent fails to disclose any structure for performing the recited function. Similar, in its opening statement, Genlyte does not indicate any structure in the specification for performing the recited function. Thus, it has failed to present a complete claim interpretation. Ignoring the deficiencies of the '254 patent, Genlyte improperly suggests that a minor reference in the specification to a "troffer" is sufficient, in combination with knowledge of a person skilled in the art, to define a ceiling-mounting structure. Gentlye's position is factually and legally erroneous.

First, the ‘254 patent does not identify a “troffer” as being a structure of the lighting system. Genlyte has take a brief phrase out of context in an unsuccessful attempt to support the claim. The sentence from which Genlyte quotes states:

> An important feature of the present invention resides in the orientation of the lamps within the lighting 1 fixture which permits the lighting fixture 10 to be packaged in a two foot by four foot configuration and thereby replace a conventional troffer.

When read in context, the ‘254 patent does not state or suggest that the lighting fixture is troffer, but that it is the size of a conventional troffer. The important feature, as stated in the ‘254 patent, is that the lamps are oriented to allow the fixture to be in a two by four foot configuration. In such a configuration, it can replace a conventional troffer. Thus, the ‘254 patent specification does not disclose a structure for ceiling mounting a body. It merely discloses a size for the body.

Second, even if the ‘254 patent specification did indicate that the lighting system was a “troffer,” it still fails to disclose a mounting structure. A troffer is not a structure for mounting a body. A “troffer” is defined in the Glossary of the IESNA Lighting Handbook as “a recessed lighting unit, usually long and installed with the opening flush with the ceiling.” See Report of Ian Lewin (attached hereto as Exhibit 1), Ex. B. Thus, “troffer” relates to the body of a lighting fixture and not to any structure for mounting that body on a ceiling. In fact, a variety of different mechanisms are regularly used to mount light troffers. See Report of Ian Lewin (Ex. 1), p. 3. Thus, as noted previously, the specification of the ‘254 patent fails to disclose a structure which performs the function of ceiling mounting the body.

Third, knowledge of a person of skill in the art cannot overcome a failure to disclose structure in the specification. Genlyte suggests that a person of skill in the art would know a troffer to be a structure having a flange and/or mounting holes. While the claims must be interpreted as understood by one of skill in the art, for means-plus-function claim language, the

structure must be in the specification, not just known to one of skill in the art. At stated by the Federal Circuit, in a case cited by Genlyte, "the inquiry asks first whether structure is described in specification, and, if so, whether one skilled in the art would identify the structure from that description." *Atmel Corp. v. Information Storage Devices*, 198 F.3d 1374, 1381 (Fed. Cir., 1999). Thus, the specification must disclose the structure. It is not sufficient to rely upon knowledge of one of ordinary skill as to related structures. *Default Proof Credit Card v. Home Depot U.S.A.*, 412 F.3d 1291, 1302 (Fed. Cir., 2005) ("The testimony of one of ordinary skill in the art cannot supplant the total absence of structure from the specification."); *Cardiac Pacemakers, Inc. v. St. Jude Med., Inc.,* 296 F.3d 1106, 1119 (Fed. Cir., 2002) (specification must include all structure that actually performs the recited function). Thus, Genlyte cannot rely upon testimony of Mr. Lemons as to structures known to those of skill in the art, since the specification fails to disclose any such structures.

The '254 patent fails to disclose any structure corresponding to the means for ceiling-mounting said body. The brief reference to a "troffer" does not disclose a mounting structure, factually or legally. Accordingly, this claim element cannot be interpreted and the claim remains indefinite.

II. <u>Genlyte Failed to Provide an Interpretation of "To Direct Light"</u>

The claims of the '254 patent recite a lighting system having several fixtures. Each of the fixtures is recited as "oriented to direct light." In its Opening Statement, Genlyte asserted that this means "to set or arrange to direct light." This definition is insufficient since it fails to define "to direct light" which is required in order to determine how the fixture is "set or arranged."

As noted in ALS's Opening Statement, "to direct" means "to follow a straight course with a particular destination." In accordance with this ordinary definition, the light fixtures of the claims must be set or arranged to control the light so that it goes on a course to a specified destination. However, light tends to spread in many directions and is not easily contained. For this reason, with respect to light, "to direct light" is understood by one of skill in the art to mean that the highest intensity light from the fixture is aimed at the indicated destination. *See* Report of Ian Lewin (Ex. 1), pp. 1-2. Genlyte has not suggested any other interpretation. Accordingly, the claims of the '254 patent should be interpreted such that the fixtures are set or arranged to cause the highest intensity light to be aimed in the recited direction to the recited target, as set forth in ALS's Markman Statement.

III. Directed Light Requires a Specular or Semi-Specular Reflector.

Genlyte suggests that the term "reflector," as used in claims 2 and 4, merely means "a device that redirects light." While that definition is common within the lighting industry, it is incomplete with respect to the claims of the '254 patent. The reflectors in claims 2 and 4 are part of the fixtures recited in claims 1 and 3. The claims recite that the fixtures are "oriented to direct light." Thus, a reflector, being part of the fixture, must also direct light from the fixture. It cannot reflect light in any direction, which is the ordinary meaning of a reflector, or it would not comply with the claim from which it depends. In order to direct light from a reflector, a specular or semi-specular surface is required. *See* Report of Ian Lewin (Ex. 1), pp. 2-3. Accordingly, the reflector in claims 2 and 4 must be interpreted to be "a specular or semi-specular device for redirecting light."

IV. CONCLUSION

There is little disagreement as to the interpretation of the claims of the '254 patent. The terms are generally construed in accordance with their ordinary meanings, as set forth in the opening statements of both ALS and Genlyte. Nevertheless, Genlyte's proposed interpretations include three errors. First, the specification fails to disclose structure corresponding to the "means for ceiling-mounting said body" in claims 1 and 3, and these elements cannot be properly interpreted. Second, Genlyte has failed to interpret the term "to direct light." This term should be interpreted to mean that the highest intensity light is aimed in a stated direction to a stated target area. Third, the term "reflector" must be interpreted to include only specular and semi-specular surfaces. Accordingly, the claim interpretations set forth in ALS's opening statement are correct and should be utilized by the court.

Respectfully submitted,

Dated: June 5, 2006

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CERTIFICATE OF SERVICE

I hereby certify that this document filed through the ECF system will be sent electronically to the registered participants as identified on the Notice of Electronic Filing (NEF) and paper copies will be sent to those indicated as non-registered participants on June 5, 2006.

Brett N. Dorny

DEFENDANT'S RESPONSE TO PLAINTIFF'S OPENING MARKMAN STATEMENT

EXHIBIT 1

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

GENLYTE THOMAS GROUP LLC, **Plaintiff/Counterclaim Defendant,** **v.** **ARCHITECTURAL LIGHTING SYSTEMS, a division of ARCH LIGHTING GROUP,** **Defendant/Counterclaimant.**	**Civil Action No. 05-CV-10945 REK**

Report by IAN LEWIN

June 2, 2006

I have reviewed the opening "Markman" statement by Genlyte Thomas Group LLC dated May 18, 2006, and the attachments thereto, including the statement of Thomas Lemons. There appears to be considerable agreement between the parties, but it is my opinion that several points require further clarification.

- **Genlyte Has not Defined the Term "Direct"**

The term "direct" is contained in a phrase defined by Genlyte; "Oriented to direct light" is stated to mean "to set or arrange to direct light." However, while this definition clarifies that "oriented" means "to set or arrange," the phrase "to direct light" is unclear. "To direct light", if not defined, may be misconstrued to mean that the term covers light that simply spills out of the fixture in particular directions. Clearly this is not the intent of the invention, which the patent makes clear is the projection of the main beam of light onto certain target areas, which are different for the first, second and third fixtures.

In my statement of May 16, 2006, I provided the rationale for understanding that to "direct" light means the "purposeful directing of the highest intensity of light toward a target." I provided an analogy where if a hiker at night needs to read a sign, he can direct his flashlight to the sign. This clearly means that he shines the main beam of the flashlight, that is, its highest intensity, toward the sign.

In another situation, if our hiker were carrying a simple lantern that had no lens or reflector, but consisted of a bulb or flame that gave light more-or-less in all

directions, some of that light presumably would fall on the sign, but in no way could it be said that the light is being *directed* to sign.

Other analogies may be drawn. Consider a floodlight that has been designed to light a monument. To achieve its purpose, the light from the floodlight is directed to the monument. i.e. The highest intensity of light, usually in the center of the beam, is aimed at the monument. If the floodlight were to be aimed in some different direction, perhaps toward trees adjacent to the monument, then some spill light may still strike the monument, but the floodlight no longer can be considered to be directed to the monument. The meaning of "directing" light is quite clear; the term refers to the aiming of the highest intensity towards the intended target.

I have pointed out in my statement that this use of the term "direct" is clearly what the inventor means in the patent, as expressed in the specification. For example, the second light fixture is "designed to direct light toward a vertical wall abutting the head of the patient's bed … ." The purpose is stated to be a means of eliminating glare, by directing light to the wall rather than to the patient's eyes, so providing reflected light from the end wall to illuminate a large area around the bed without causing glare to the patient. This is contained in the "Objects and Summary of the Invention" section and is not simply part of a preferred embodiment.

- **Reflectors Used to Direct Light to a Particular Target Must Be Specular or Semi-specular**

In order to form a concentration of light toward a particular target, that is, to create a high intensity of light that can be aimed, the reflector employed must have a specular (mirror-like) or semi-specular finish. Only with these surfaces can light be properly and efficiently reflected toward a target.

In the 8^{th} Edition of the Handbook of the Illuminating Engineering Society of North America, the section on "Parabolic Reflectors," which are used to create a beam of light where the rays are parallel or near-parallel, states "All light from the source striking the *mirror* is *redirected* as a beam of light parallel to the parabolic axis." (Italics added). Exhibit A. A mirror–like surface is needed to produce the concentrated beam of light that is aimed at the target. The text further states "The further conditions deviate from these, (a perfect mirror and a point source of light), the greater will be the deviation of the light from a parallel beam." (Parenthetic phrase added). In other words, when a greater spread of light is needed than would be provided by a perfectly specular surface, a less specular, or "semi-specular," surface can be used.

I note use of the term "redirected" to express concentration of light into a beam that will be aimed at a target.

White painted metal can be used to form a reflector that is predominantly diffuse, with only a minor specular reflection occurring if there is some surface gloss. Such a reflector is not effective in producing light rays that can be efficiently directed towards a target. With reference to a diffuse reflecting surface, the IESNA Handbook states “In this case, there is little that can be done by the designer in the way of light control except by aiming the entire reflector.” Exhibit A.

It is therefore clear that in order to direct light to a target, the reflector used must be specular or semi-specular, and cannot be white painted.

- **The Form of Mounting the Patented Product Is not Disclosed**

I have been requested to comment on the patent specification statement whereby the covered device can “replace a conventional troffer.”

A “troffer” is defined in the Glossary of the IESNA handbook as “a recessed lighting unit, usually long and installed with the opening flush with the ceiling.” Exhibit B. Nothing in this definition, nor any statement in the ‘254 patent, provides any detail regarding any structure related to how the troffer might be installed in a hospital bedroom. There are numerous possible mounting methods for a troffer:

- The troffer may be laid in a T-bar ceiling grid.
- It may be screwed to ceiling joists that lie adjacent to it.
- It can be screwed via holes in its top to a horizontal building structure that lies above the ceiling level.
- It may be suspended by wire or cables from the building structure that lies above the ceiling plane.

I further note that in the statement of Thomas Lemons, he defines “means for ceiling mounting said body” as “Surface or recessed installation on or into a ceiling.” I believe this definition is incorrect, as per the IESNA Glossary, a troffer must be recessed and therefore cannot be surface mounted on a ceiling.

Ian Lewin

Ian Lewin Ph.D., FIES, L.C.
June 2, 2006

REPORT OF IAN LEWIN
EXHIBIT A

8TH EDITION

LIGHTING HANDBOOK

REFERENCE & APPLICATION

ILLUMINATING ENGINEERING SOCIETY
OF NORTH AMERICA

sium fluoride and titanium dioxide, are vacuum deposited on such materials as glass, aluminum and plastics. The coatings of interest for lighting uses are multilayered and less than 1 μm thick.

Laminates

This type of finish is created by bonding a thin layer to a base material, such as a plastic film to sheet metal. The laminate can be a decorative material or it can be a light-controlling material.

Chemical Conversion Finishes

Anodizing converts an aluminum surface by an anodic process to aluminum oxide, which has outstanding protective qualities against corrosion and abrasion. The resultant finish may be clear or can be dyed in a variety of colors.

REFLECTOR DESIGN[11]

The design of reflector contours is an extensive subject because the possible shapes for a particular application are almost limitless. The end use, however, usually limits the choice.

For design purposes, reflector contours can be divided into two classes, basic and general contours. Basic contours may be defined as those which are highly predictable as to light distribution and can be designed mathematically. General contours are those required to satisfy many intensity distribution curves, but which do not conform to any of the basic contours.

Basic Reflector Contours

Basic contours that are used very frequently are the conic sections and the spherical reflector.

A conic section is, by definition, the locus of points having distances from a fixed point that are in a constant ratio to the distances from a fixed straight line. The fixed point is called the focus of the conic section, the fixed line is its directrix. The constant ratio is the *eccentricity* e of the conic section.

If $e = 1.0$ then the section is called a *parabola*.
If $e < 1.0$ then the section is an *ellipse*.
If $e > 1.0$ then the section is a *hyperbola*.

Parabolic Reflectors. An inherent property of the parabola is its ability to redirect a ray of light originating at its focal point along a direction parallel to the axis of the parabola. The proof of the property is shown in figure 7-7, where $A'A''$ is tangent to the curve at A, BA is perpendicular to DD', and $BA = FA$. If the parabola is rotated about its axis (the line indicated by the X), a *paraboloid* is swept out. Assume a per-

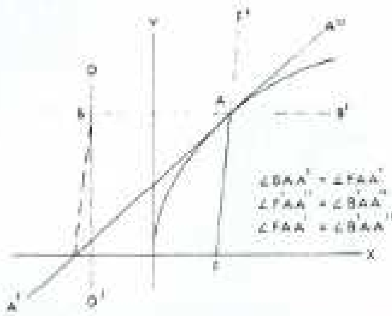

Fig. 7-7. Parabolic conic section. DD' is the directrix; F is the focus.

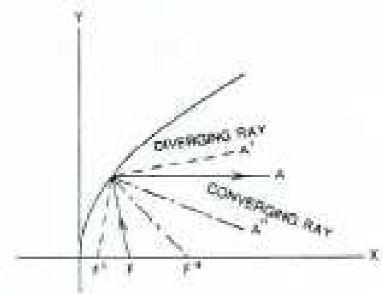

Fig. 7-8. Diverging or converging rays from a point source on the axis of a parabolic reflector, but behind or ahead of the focal point F.

fectly specular mirror is made to this shape, and that a point source is at the focus (F). All light from the source striking the mirror is redirected as a beam of light parallel to the parabolic axis. The ideal conditions of perfect specularity and a point source cannot be reached in practice, nor, in most cases, would this be desirable. The further conditions deviate from these, the greater will be the deviation of the light from a parallel beam. Formulas have been derived expressing the light divergence fromshallow mirrors when sources of various shapes are used. Figure 7-8 illustrates the action of point sources lying on the axis of the parabola (line X) but ahead of (F'') or behind (F') the focal point F.

Ellipsoidal Reflectors. If an ellipse is rotated about its major axis, a surface is swept out which is an *ellipsoid*. This surface, having two foci, will take light from one focus and reflect it through the other focus. Ellipsoidal reflectors are an efficient means for producing beams of controlled divergence and for collecting light to be controlled by a lens or lens system.

The ellipse shown in figure 7-9 can be described as the set of points (x, y) on the X, Y plane such that the following equation is satisfied:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \qquad (7\text{-}1)$$

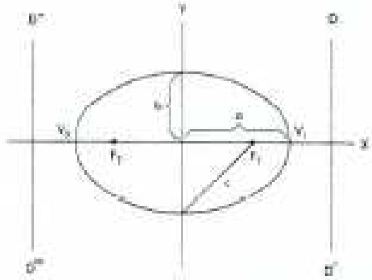

Fig. 7-9. The foci (F_1 and F_2), directrices (DD' and $D''D'''$), and axes of an ellipse.

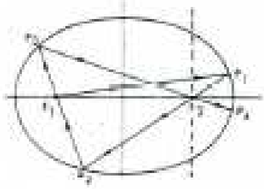

Fig. 7-10. The action of a perfect ellipsoidal mirror.

Useful working equations are

$$y = \pm \frac{b}{a}\sqrt{a^2 - x^2} \qquad (7\text{-}2)$$

$$x = \pm \frac{a}{b}\sqrt{b^2 - y^2} \qquad (7\text{-}3)$$

$$b^2 = a^2 - \left(\frac{\overline{F_1F_2}}{2}\right)^2 \qquad (7\text{-}4)$$

Figure 7-10 illustrates the action of a perfect complete ellipsoidal mirror with a light source at F_1 and a ray of light striking the mirror at P_1, passing through F_2 (the conjugate focus) to P_2, and being reflected again through F_1 to P_3 and on to P_4. If the mirror is "chopped off" at F_2 (the dashed line) or at a point closer to F_1, all of the light from the theoretical source at F_1 will leave the mirror either directly or after one reflection. By moving the opening back along the major axis, the beam limits of the reflected light are narrowed. When the plane of the opening reaches the center of the ellipse, the maximum angle of the reflected light coincides with the angle of direct emission from the source.

Hyperbolic Reflectors. The diverging beam typical of the ellipsoidal reflector can also be produced by a reflector having a hyperbolic contour. The main difference, as shown in figure 7-11, is that the hyperbolic reflector produces a virtual image, F_2, behind the focus, whereas the ellipsoidal reflector produces a real image in front of the focus.

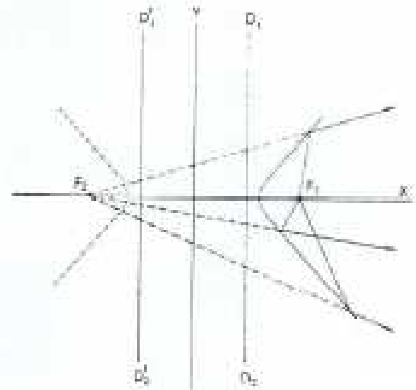

Fig. 7-11. Hyperbolic reflector action.

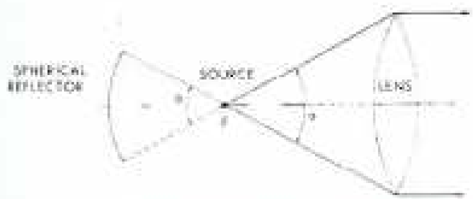

Fig. 7-12. Projecting device with a spherical reflector.

Spherical Reflectors. A spherical reflector can be considered as a special form of the ellipsoidal reflector where the two foci are coincident. Any light leaving the source located at the focus will return and pass through the same point. This has obvious disadvantages when dealing with practical sources, since the concentration of energy can often damage the source or the bulb wall surrounding it. The principle is, however, often used in projecting devices to increase the amount of light collected by a lens as shown in figure 7-12.

General Reflector Contours

For many applications, reflectors can be designed which are mathematically predictable as to contour and action. A more general problem is that of determining the contour of a reflector which does not meet these conditions. Usually there are two specified factors: an approximate luminous intensity distribution for the finished reflector, and the material from which it is to be manufactured.

Diffuse Reflecting Surfaces. In the rare case of surfaces with perfectly diffuse reflection, the contour of the reflector has very little effect on the distribution of light. The luminous intensity distribution of such a reflector (after that portion due to the bare lamp has been deducted) is very nearly spherical, with the maximum value normal to the plane of the opening. The distribution is not perfectly spherical, because portions

of the reflector are not uniformly illuminated. A strip of unit area near the lower edge of the reflector, being farther from the source, receives less light than a similar strip higher in the reflector. Since these lower portions are the parts directing light out at the upper angles, the intensity decreases faster than the cosine of the angle. In this case, there is little that can be done by the designer in the way of light control except by aiming the entire reflector.

Reflectors with Specular and Semispecular Surfaces. General contours for specular reflectors are usually obtained through graphical or computational methods. The problem consists in determining what reflector shape is necessary to redirect luminous flux from the lamp into the proper directions to achieve a predetermined luminous intensity distribution.

The basic steps in one method of determining a reflector contour are shown below.[12] In this method, the lamp is approximated by a point source with an axially symmetric luminous intensity distribution. Additionally, the required luminous intensity distribution is assumed to be axially symmetric. This simple procedure lends itself to computer implementation, resulting in an effective way to automate the reflector shape synthesis process:

1. Select the width, in degrees, of the annular zones to be considered. From the required candela distribution, calculate the luminous flux required in each zone. (Flux in each zone = candelas × zonal constant.) See chapter 9, Lighting Calculations. Tabulate these values.
2. Calculate the luminous flux emitted by the bare lamp in each zone, using the luminous intensity distribution of the bare lamp and the zonal constants, and tabulate.
3. Find the reflected lumens needed in each zone by subtracting the bare-lamp lumens (data from step 2) from the required luminous flux (data from step 1) in those zones where no reflection will take place; in other words, from nadir up to cutoff. Tabulate these values.
4. Decide upon the general action of the reflector. There are, in general, four basic actions of the reflectors as shown in figure 7-13. For a given cutoff, the forms shown in figure 7-13c and d usually require a very large reflector. The form in figure 7-13b has the disadvantage that much of the light is passed through the lamp bulb. For most cases, the form in figure 7-13a results in the smallest reflector and redirects the least light back through the lamp.
5. Plot a curve of the reflected flux obtained in step 3. Starting at 0°, show cumulative sums of lumens required to be reflected into each zone from nadir up to cutoff; see figure 7-14. Similarly, plot a curve of available lamp flux (from the step 2 data). Starting at cutoff, show how many lumens are incident on the reflector progressively from cutoff to 180° (figure 7-14b). Since all flux considered here must be reflected from the reflector surface, the available lamp lumens must be multiplied by the reflectance of the surface and by other loss factors. It is convenient to work with rectangular coordinates, plotting the lumens along the horizontal axis and degrees along the vertical axis. Plot the reflected-flux curve (figure 7-14a) to the same scale and directly below the curve of available lamp flux (bare-lamp flux corrected for losses). If the reflector action illustrated in figure 7-13b or d was selected, the horizontal (lumen) scales of the two curves will be in the same direction. If figure 7-13a or c was selected, the scales will be reversed as shown in figure 7-14. Take intercepts at intervals (one for each zone) along the reflected-flux curve (figure 7-14a), and project upward to the available-lamp-flux curve as shown in figure 7-14. At the point where each intercept cuts the available-lamp-flux curve (figure 7-14b), project horizontally to degrees on the vertical axis. The spacings between intercepts on the vertical axis indicate how large an angular zonal segment of the reflector is required to

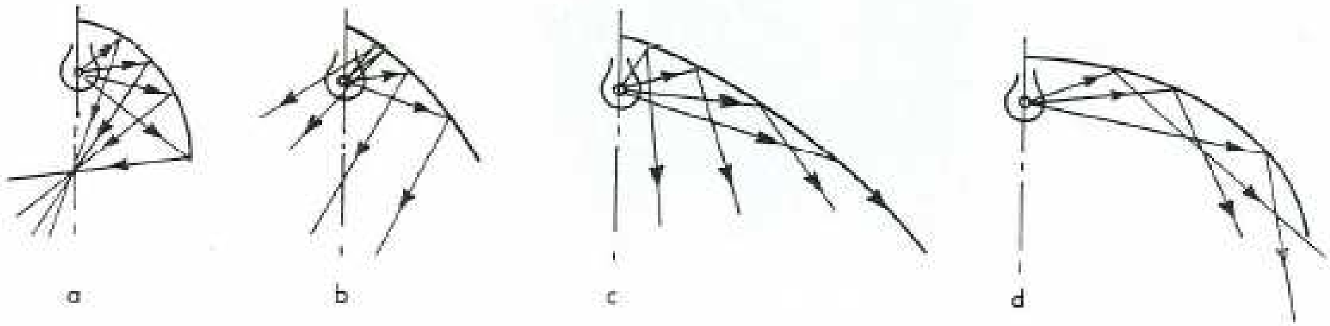

Fig. 7-13. Four basic reflector actions.

REPORT OF IAN LEWIN
EXHIBIT B

solid angles. These concepts must be applied with care if the area of the transmitting element is not large compared to its thickness, in view of internal transmission across the boundary of the area. For many geometrically specified transmittance properties it is assumed that the radiance (luminance) is isotropic over the specified solid angle of incidence. Otherwise, the property is a function of the directional distribution of incident radiance (luminance) as well as the beam geometry and the character of the transmitting surfaces or media. Most transmittance quantities are applicable only to the transmittance of thin films with negligible internal scattering, so that the transmitted radiation emerges from a point that is not significantly separated from the point of incidence of the incident ray that produces the transmitted ray or rays. The governing considerations are similar to those for application of the bidirectional reflectance distribution function (BRDF), rather than the bidirectional scattering-surface reflectance distribution function (BSSRDF).

transverse roadway line (TRL) any line across a roadway that is perpendicular to the curb line.

tristimulus values of a light, *X*, *Y*, *Z* the amounts of each of three specific primaries required to match the color of the light.

troffer a recessed lighting unit, usually long and installed with the opening flush with the ceiling. The term is derived from "trough" and "coffer."

troland a unit of retinal illuminance which is based upon the fact that retinal illuminance is proportional to the product of the luminance of the distal stimulus and the area of entrance pupil. One troland is the retinal illuminance produced when the luminance of the distal stimulus is 1 cd/m² and the area of the pupil is 1 mm².
Note The troland makes no allowance for interocular attenuation or for the Stiles-Crawford effect.

tube See *lamp*.

tungsten-halogen lamp a gas-filled tungsten incandescent lamp containing a certain proportion of halogens in an inert gas whose pressure exceeds 3 atm.
Note The tungsten-iodine lamp (U.K.) and quartz iodine lamp (U.S.) belong to this category.

turn signal operating unit that part of a signal system by which the operator of a vehicle indicates the direction a turn will be made, usually by a flashing light.

U

ultraviolet lamp a lamp which radiates a significant portion of its radiative power in the ultraviolet (UV) part of the spectrum; the visible radiation is not of principal interest.

ultraviolet radiation for practical purposes any radiant energy within the wavelength range 10–380 nm. See *regions of the electromagnetic spectrum*.
Note On the basis of practical applications and the effect obtained, the ultraviolet region often is divided into the following bands:

Ozone-producing	180–220 nm
Bactericidal (germicidal)	220–300 nm
Erythemal	280–320 nm
"Black light"	320–400 nm

There are no sharp demarcations between these bands, the indicated effects usually being produced to a lesser extent by longer and shorter wavelengths. For engineering purposes, the "black light" region extends slightly into the visible portion of the spectrum. Another division of the ultraviolet spectrum often used by photobiologists is given by the CIE:

UV-A	315–400 nm
UV-B	280–315 nm
UV-C	100–280 nm

units of luminance[†] the luminance of a surface in a specified direction may be expressed as luminous intensity per unit of projected area of surface or as luminous flux per unit of solid angle and per unit of projected surface area.
Note Typical units are the cd/m² [lm/(sr · m²)] and the cd/ft² [lm/(sr · ft²)]. The luminance of a surface in a specified direction is also expressed (incorrectly) in lambertian units as the number of lumens per unit area that would leave the surface *if the luminance in all directions within the hemisphere on the side of the surface being considered were the same as the luminance in the specified direction*. A typical unit in this system is the footlambert (fL), equal to 1 lm/ft². This method of specifying luminance is equivalent to stating the number of lumens that would leave the surface *if the surface were replaced by a perfectly diffusing surface with a luminance in all directions within the hemisphere equal to the luminance of the actual surface in the direction specified*. In practice no surface follows exactly the cosine formula of emission or reflection; hence the luminance is not uniform, but varies with the angle from which it is viewed. For this reason, this practice is denigrated.

unrecoverable light loss factors See *nonrecoverable light loss factors*.

upper (driving) beams one or more beams intended for distant illumination and for use on the open highway when not meeting other vehicles. Formerly "country beams." See *lower (passing) beams*.

upward component that portion of the luminous flux from a luminaire emitted at angles above the horizontal. See *downward component*.

utilance See *room utilization factor*.

V

vacuum lamp an incandescent lamp in which the filament operates in an evacuated bulb.

valance a longitudinal shielding member mounted across the top of a window or along a wall and usually parallel to the wall, to conceal light sources giving both upward and downward distributions.

valance lighting lighting comprising light sources shielded by a panel parallel to the wall at the top of a window.

values of spectral luminous efficiency for photopic vision, V(λ) values for spectral luminous efficiency at 10-nm intervals (see chapter 1, Light and Optics) were provisionally adopted by the CIE in 1924 and were adopted in 1933 by the International Committee on Weights and Measures as a basis for the establishment of photometric standards of types of sources differing from the primary standard in spectral distribution of radiant flux.